



Anatomy of a Planetary Network

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Outline

- Planetary Network: what is it, why build one?
- Building the Terrestrial Internet
- Why a Planetary Network will be different
- Case study: a Planetary Network for Mars
- Some technical considerations
- Closing thoughts

Planetary Networks (1 of 2)

- On Earth we have a terrestrial network named “the Internet” that simplifies coordination among people and automated systems on a planetary scale.



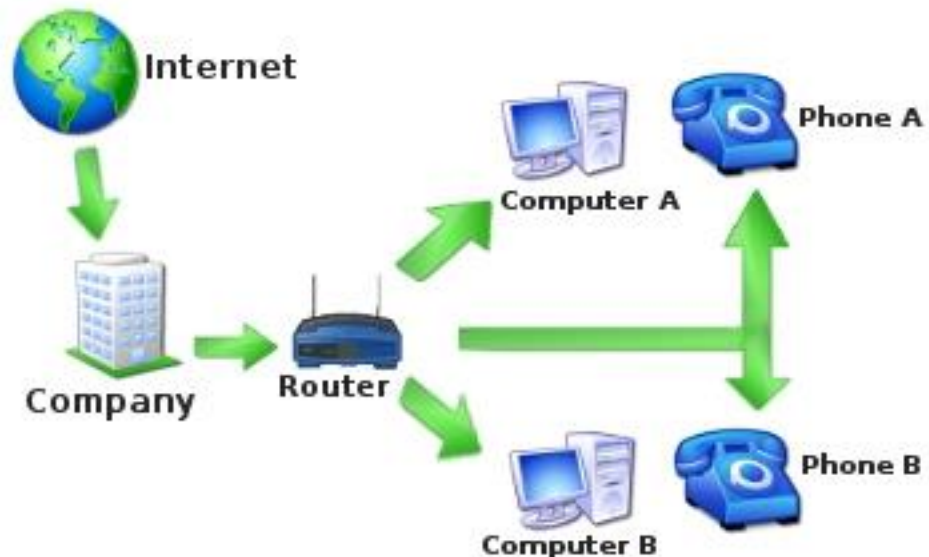
Planetary Networks

- When we begin exploring and settling other planets, that coordination among people and automated systems may prove useful there as well.
- So maybe we will want “planetary networks”, functionally analogous to the Internet, on other planets.



Building the Terrestrial Internet

- The earliest precursors to today's Internet were small networks. The physical layer of the network stack was wires strung through a laboratory.
- Use of the Internet on a national – and later planetary – scale was made possible by the availability of a planetary-scale physical layer infrastructure that was already in place: the telephone system.

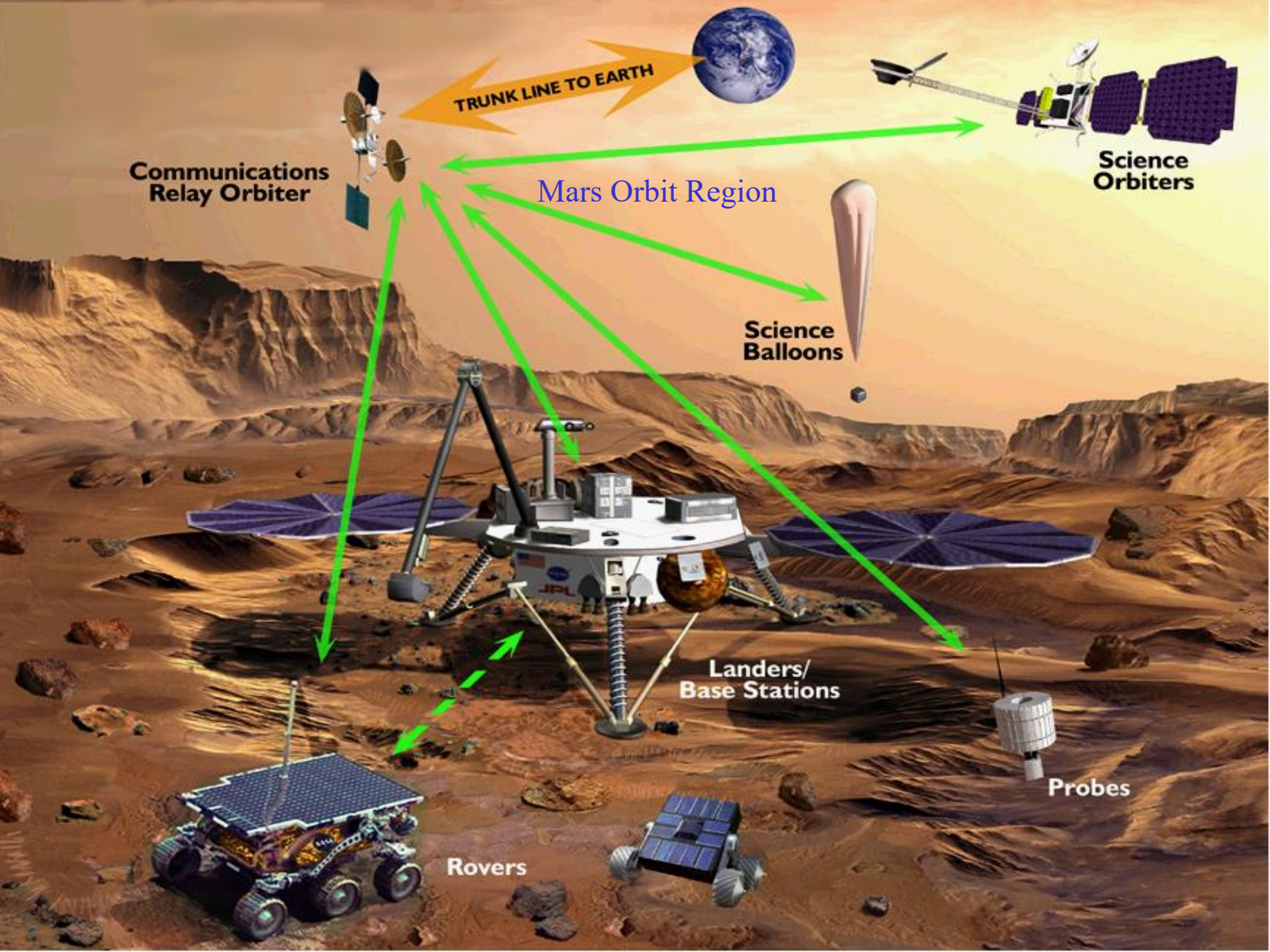


Planetary Networks Are Different

- There is no phone system. The entire physical signal transmission system has to be installed from scratch, to give the Internet a physical layer to run over.



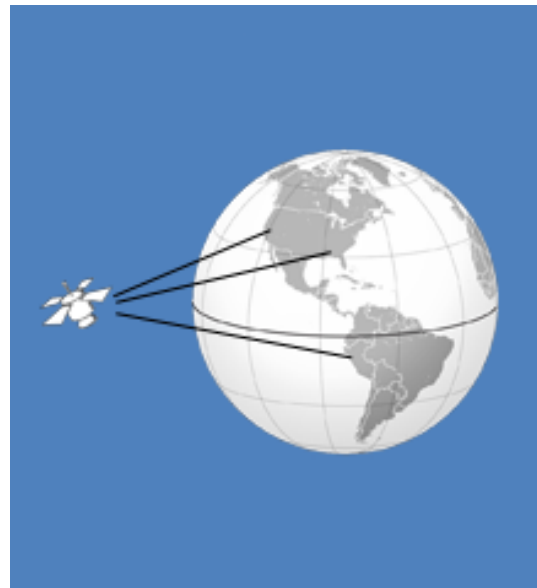
- That physical layer won't be copper wires or optical fiber on a planetary scale. It will be radio transmission and/or free-space optical transmission.





A Planetary Network for Mars

- We already know how to build planetary-scale networks using radio and free-space optical transmission: we use satellites.

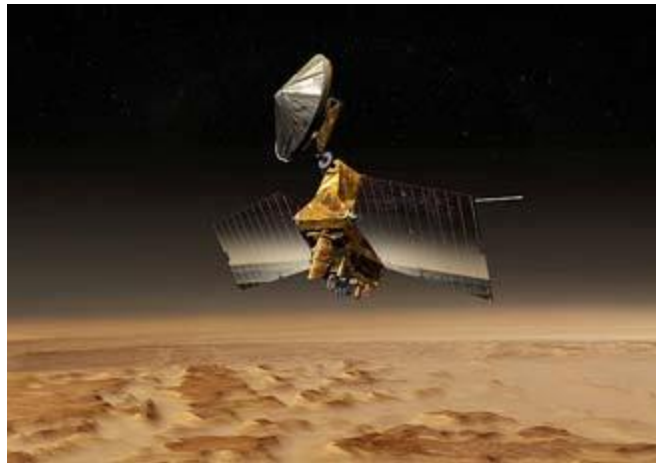


- Satellites in geostationary (for Mars, areostationary) orbit can sustain continuous end-to-end Internet connections.



A Planetary Network for Mars

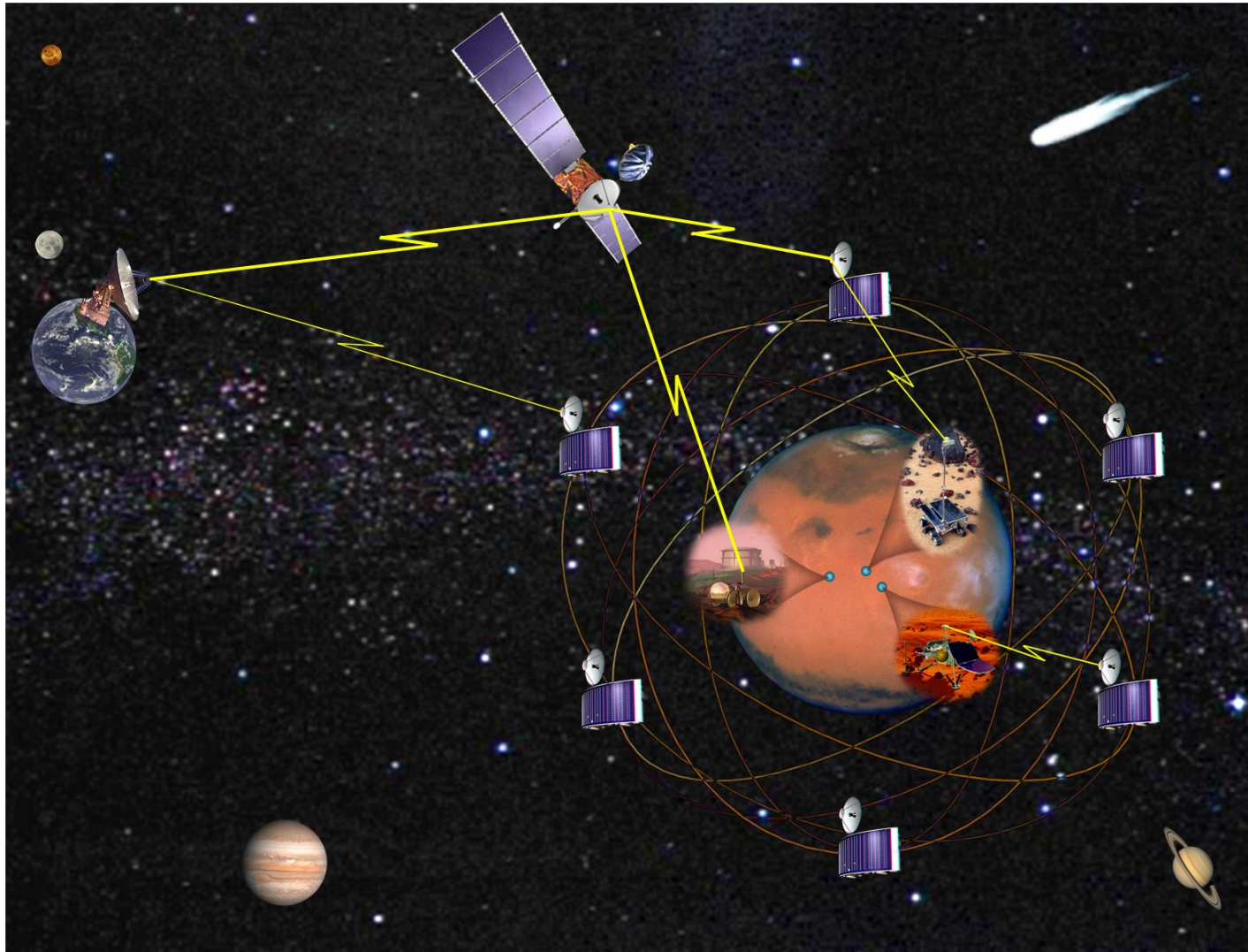
- Satellites in low-Earth (or low-Mars) orbit can establish transient connections, serving as data mules.



- Satellites in low-Earth (or low-Mars) orbit with cross-links among them can sustain continuous end-to-end Internet connections.



Mars Planetary Network





Technical Considerations

- To sustain continuous end-to-end Internet connections in the Mars network we will need:
 - Areostationary satellites, each of which (a) can serve only a portion of the planet and (b) will likely be expensive, or
 - A large number of low-Mars communication satellites with cross-links, which can serve the entire planet but will likely also be expensive.
- Environmental conditions may disrupt communication with satellites, making Internet communication possible.
- A data mule architecture, utilizing a growing fleet of low-Mars satellites without cross-links and enabled by the use of Delay-Tolerant Networking protocols, could mitigate environmental disruption and provide planetary network service at low cost.



Where we are

- Terrestrial communication satellite systems such as ViaSat and Iridium demonstrate that the architectural options available for Planetary Networks are practical.
- Delay-Tolerant Networking is currently deployed on the International Space Station in low-Earth orbit.
 - Operational over the TDRSS geostationary satellite infrastructure.
 - Also a platform for DTN experiments over transient ground contacts.





Thanks!

Questions?

